Site Need Statement

General Reference Information	
1 *	***Need Title:*** Alternate Retrieval Methods from Potentially Leaking Single-Shell Tanks (SSTs)
2 *	***Need Code:*** RL-WT089
3 *	***Need Summary:*** Between 1944 and 1964, 149 SSTs were built in the 200 East and 200 West Areas on the Hanford Site central plateau. Sixty-seven of Hanford's 149 SSTs are confirmed or assumed leakers that have leaked an estimated 750,000 to 1,050,000 gallons to the surrounding vadose zone (HNF-EP-0182-148, "Waste Tank Summary Report for Month Ending July 31, 2000). The SSTs currently contain approximately 35 million gallons of waste. Although no waste has been added to the SSTs since November 1980, all of the SSTs have exceeded their original design life of roughly 20 years and continue to deteriorate over time. The baseline method for Single-Shell Tank (SST) waste retrieval is "past practice" hydraulic sluicing. While this technique has proven to be effective in tanks believed to be sound, hydraulic sluicing raises concerns in tanks that are known or suspected to be leaking. These concerns are due, in part, to the reliance on the use of liquids to mobilize and retrieve the wastes. A need exists for alternate waste retrieval technologies that use little or no liquids to mobilize and retrieve SST wastes from potentially leaking tanks.
4 *	***Origination Date:*** FY 2001
5 *	***Need Type:*** Technology Opportunity
6	***Operation Office:*** Office of River Protection
7	***Geographic Site Name:*** Hanford Site
8 *	***Project:*** Retrieval ***PBS No:*** RL-TW04
9	***National Priority:*** _X_ 1. High - Critical to the success of the EM program, and a solution is required to achieve the current planned cost and schedule. ____ 2. Medium - Provides substantial benefit to EM program projects (e.g., moderate to high life-cycle cost savings or risk reduction, increased likelihood of compliance, increased assurance to avoid schedule delays). ____ 3. Low - Provides opportunities for significant, but lower cost savings or risk reduction, may reduce the uncertainty in EM program project success.
10	***Operations Office Priority:*** High
Problem Description Information	
11	***Operations Office Program Description:*** The Single-Shell Tank (SST) Interim Closure Project is responsible for Program/Project Planning and Execution; Environment, Safety, Health, and Quality Assurance; Facility Operations; Engineering; Maintenance; Interim Stabilization; and Technology Development, Demonstrations, and Deployments necessary for the safe and cost effective storage, retrieval, immobilization, and closure of SST wastes, associated underground storage tanks, and ancillary piping and equipment. Safe storage of wastes includes day-to-day operations of the SST's and saltwell pumping operations to remove pumpable liquids from the SST's for transfer to double-shell tanks (DST's) to achieve interim stabilization and minimize the potential for SST leakage. Retrieval projects will be conducted to remove wastes from SST's for placement in DST's in support of waste feed delivery to the Waste Treatment Plant and eventual waste immobilization. An integral part of SST waste retrieval operations is leak detection, monitoring, and mitigation. Safe storage, retrieval, and closure activities associated with SST wastes are also supported by Special Projects and Vadose Zone Projects to characterize groundwater flow and contaminant transport phenomena, geohydrological conditions, and the nature and extent of contaminant plumes.
12	***Need/Problem Description:*** Sixty-seven of Hanford's 149 SSTs are confirmed or assumed leakers. All 149

                                          ** ** **	SSTs have exceeded their design lives by 20 to 40 years and they continue to deteriorate with time. The primary mode of SST failure has been determined to be stress corrosion cracking. The configuration of SSTs and the wastes contained therein make it difficult to conduct tank integrity testing in support of tank failure analyses. Additionally, the SSTs do not conform to current Resource Conservation and Recovery Act requirements for underground storage tank design and operations. Consequently, there is a “bias for action” to minimize the potential for tank leakage to the environment. This “bias for action” is being accomplished through interim stabilization of the SSTs to remove pumpable liquids followed by the ultimate retrieval and processing of remaining SST wastes. Although “past practice” sluicing was recently used in FY 1999 to retrieve SST wastes in tank C-106 (a sound tank not suspected to be leaking), there is concern over adding liquids to tanks of questionable integrity due to the possibility of creating tank leaks or exacerbating existing leaks thereby driving contaminants deeper into the vadose zone and possibly into the groundwater system beneath the SST tank farms. A need exists to demonstrate waste retrieval technologies that use little to no liquids to mobilize and retrieve tank wastes. Those technologies proposing the use of limited amounts of liquids must demonstrate the ability to conduct leak mitigation during retrieval operations should a leak be detected. **Consequences of Not Filling Need:** Given (1) the age of the SSTs, (2) the fact that 67 SSTs are confirmed or assumed leakers and they continue to deteriorate, (3) all SSTs have exceeded their design lives, and (4) tank configuration makes it difficult to perform tank integrity inspections, the consequences of not filling this need is increased potential for leakage losses during retrieval operations if past practice sluicing is used. This could result in cessation of tank waste retrieval operations with resultant impacts to waste feed delivery to the Waste Treatment Plant. Furthermore, if the leakage losses are great enough and migration to the water table is imminent, then the tank farm could be thrust into RCRA assessment and corrective action mode with associated costs for characterization, evaluation, and remediation. At a minimum, increased tank farm surveillance will be required to track the fate and transport of leaked contaminants through the vadose zone. Failure to fill this need will also impede efforts to find more environmentally acceptable technologies for waste retrieval that minimize or eliminate the use of liquids to mobilize and retrieve wastes or provide adequate leak mitigation provisions to minimize the likelihood of leakage losses during retrieval operations if limited amounts of liquids are used. The current past practice sluicing baseline has relatively high costs and uncertain performance efficiency given the variety of waste forms in the SSTs. This need statement addresses demonstration of alternative retrieval technologies and the development of cost and performance data for each technology to support cost-benefit tradeoffs during pre-conceptual and conceptual retrieval system design efforts. **Program Baseline Summary (PBS) No.:** TW04 **Work Breakdown Structure (WBS) No.:** 5.02.01.01.01.01, 5.02.01.01.03.02 **TIP No.:** M45 Series TPA Milestones
13	***Functional Performance Requirements:*** The SSTs currently contain approximately 35 million gallons of wastes. This waste is comprised of roughly 21.5 million gallons of non-pumpable saltcake, 12 million gallons of sludge, and 1.5 million gallons of supernatant. The SSTs contain approximately 23,000 curies of contaminants of concern. Approximately 95% of these contaminants are contained in 70 of the SSTs. The SSTs also contain miscellaneous hardware (e.g., airlift circulators, thermocouple trees, steam coils, manual tapes, etc.) and other materials (e.g., experimental fuel elements, cobalt slugs, cement, diatomaceous earth, etc.). Pumpable liquids have been removed from approximately 75% - 80% of the SSTs and saltwell pumping operations continue. Current plans are to remove all pumpable liquids from the SSTs and achieve interim stabilization by 2004. Although saltwell pumping operations are removing the bulk of the liquids from the SSTs, some liquids still remain in the SSTs due to unpumpable regions and capillary action within the interstitial spaces of the waste. Some estimates suggest that as much as 50,000 gallons of liquids may still

remain in some tanks following saltwell pumping operations.

The 149 SSTs were constructed in various configurations. One-hundred thirty-three have 75 feet diameters with nominal capacities of 500,000 gallons, 750,000 gallons, or 1,000,000 gallons. The remaining 16 SSTs have 20 feet diameters and nominal capacities of 55,000 gallons.

The 75 feet diameter tanks are domed top, reinforced concrete cylinders, varying in height from 29 feet to 45 feet. The concrete cylinders are lined with steel plate on the sides and bottom. The bottoms of most tanks are dished with a depth of 12 inches. The tanks are below grade with at least 6 feet of soil cover for radiation shielding.

Risers penetrating the tank domes provide access to the tanks. Existing risers vary in diameter from 4 inches to 42 inches. Fifty-seven of the tanks contain pipes used as liquid observation wells to measure waste levels in the tanks using neutron probes, manual tapes, and other techniques. Sixty-four of the 75 feet diameter tanks do not have a 42 inch central riser for access. Thirty-nine of the 75 feet diameter tanks have four or five centrally located 42 inch risers. Although new risers can be added to the SSTs, this is a very costly proposition.

The sixteen smaller tanks are 20 feet in diameter and 24 feet in depth. They have a nominal capacity of 55,000 gallons. They are reinforced concrete cylinders with steel liners. There are several pipe penetrations in the top of the tanks ranging in size from 1.5 to 12 inches in diameter. There is also a 42 inch diameter manhole in the top of the tanks located 12 feet below grade.

The contaminants of concern that pose the greatest long-term threats and are of particular interest to the SST Program include nitrite, nitrate, ethylenediaminetetraacetic Acid, carbon-14, selenium-79, technetium-99, iodine-129, and uranium-238. These contaminants are major factors in determining subsurface investigation methods, associated corrective measures, residual tank waste criteria, and tank closure plans.

Candidate technologies must be capable of making tank entries within the confines of the tank configurations described above. In addition, retrieval technologies must use very little to no liquids to mobilize and retrieve tank wastes. If limited amounts of liquids are proposed for use, then the retrieval technology must be capable of mitigating potential tank leakage through engineering design and application (i.e., confined sluicing, auxiliary pumping, etc.). The radioactive saturated salt/saltcake waste within the SSTs is an aggressive/hazardous environment.

Technologies incorporating slurry transfer capabilities must be accomplished with minimal liquid use. The ability to restart waste transfer operations following a shutdown without additional liquid addition is highly desirable. The ability of the waste transfer system to mobilize various waste forms (i.e., fine particulates to large pieces of waste) is desirable. Although physical properties (i.e., particle size, density, viscosity, etc.) of SST waste are somewhat limited, some information is available on a tank-specific basis and can be provided.

All technologies must be capable of establishing and maintaining radiological confinement and containment to control airborne and other types of contamination spread. Furthermore, technologies that minimize the number of moving parts that must come in contact with the waste and are easy to decontaminate and maintain are highly desirable.

Possible Concepts: Tank waste retrieval projects are charged with determining the maximum leakage loss that can occur during retrieval and still comply with applicable Federal and State regulations. This allowable leakage will be based, in part, on expected residual waste volumes in the SSTs and inventories of contaminants in surrounding vadose zone soils as a result of past tank leaks.

It is unlikely that only one economically attractive retrieval technology will be suited to retrieval of all potentially leaking tanks. Furthermore, acceptable leakage volumes, if any, will likely be assessed on a tank- or tank farm-specific basis. Therefore, SST waste retrieval efforts will benefit from having a range of technologies at their disposal. Technologies of greatest interest will be those that (1) minimize or mitigate the potential for leakage losses during retrieval operations, (2) use minimal amounts of liquids and can operate with minimal liquid levels within the SSTs, and (3) incorporate dry retrieval technologies that use no water.

A multitude of candidate retrieval technologies have been identified by prior EM-50 Technology Development Programs and EM-30/EM-40 technology assessments. The following is a partial listing of retrieval technologies potentially applicable to leaking SSTs:

Dislodging, Fluidic
- Medium and high pressure water jets
- Confined sluicing
- Fluidic mixers
- Saltcake dissolution

Dislodging, Compressed Air
- Cryogenic gas
- Sand blasting
- Frozen carbon dioxide pellets

Dislodging, Mechanical
- Jack hammer
- Grinders
- Scabblers
- Diamond shavers
- Robotic crawlers with end effectors and manipulators

Dislodging, Shock Wave
- Ultrasonic horn
- Pulsed electric power
- High pressure pulsed jet

Conveyance
- Air conveyance
- Mechanical conveyance
- Multi-phase based on using in-tank supernatant

In-Tank Leak Mitigation
- Modified mining strategy
- Interim collection tank
- In-tank leak detection (e.g., tracers)
- Surface and subsurface barriers
- Leak plugging fluids (e.g., colloidal silica)
- Auxiliary pumping schemes

As mentioned previously, the Tri-Party Agreement contains requirements for retrieval technology demonstrations. Current plans are to demonstrate saltcake dissolution and fluidic pumping technologies in tanks S-112 and S-102, respectively. Tank S-112 contains 6 kgal of sludge and 517 kgal of saltcake. Tank S-102 contains 105 kgal of sludge and 387 kgal of saltcake.

Tank C-104 has been selected for demonstration of a robotic, crawler-based technology. Tank C-104 contains 263 kgal of sludge only.

In general, the SST Program has identified a need to conduct technology demonstrations in the areas of

	saltcake dissolution, confined sluicing, saltcake/sludge retrieval, dry retrieval, and congested/limited access retrieval. **Outsourcing Potential:** Demonstration of alternative retrieval technologies will identify where industry capabilities exist and where additional technology development would be beneficial. Existing technology capabilities will be infused from other industries (e.g., mining, petroleum) to benefit SST waste retrieval at the Hanford Site and elsewhere. Technology demonstrations envisioned under this need statement could result in private industry, university, and DOE Site collaborations.
**	**Schedule Requirements:** Under the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement, M-45 Series Milestones), a tentative agreement establishes a risk-based strategy and initial actions necessary for the Department of Energy to demonstrate alternative SST retrieval technologies. The technologies must be suitable for use in suspect or leaking SSTs to minimize the potential for unacceptable leakage losses to the environment during retrieval operations, and to develop performance and cost data necessary for application to future retrieval actions. In addition to demonstrating waste retrieval technologies, initial actions will focus on SSTs that pose the greatest risk to the environment and on maximizing available double-shell tank (DST) space. Key elements of the new risk-based SST retrieval strategy include: • Implement a risk-reduction strategy and retrieve the “worst tank waste” first. • Demonstrate SST waste retrieval and leak detection, monitoring, and mitigation technologies to develop cost and performance data. • Transfer no less than 800 curies of long-lived, mobile radionuclides into approximately 2 million gallons of DST space for retrieval of tanks S-112 and S-102. • Complete construction for tank C-104 retrieval that will transfer approximately 23,000 curies of plutonium into approximately 800,000 gallons of DST space. • Update tank farm closure work plans. • Assess options for creating more DST tank space. Proposed milestones and schedules for retrieval activities under the Tri-Party Agreement include the following: <u>Technology Demonstration – Tank S-112</u> • Submit functions and requirements for tank S-112 technology demonstration by 12/30/01. • Complete tank S-112 technology demonstration design by 5/31/03. • Complete tank S-112 technology demonstration construction by 9/30/04. • Complete full-scale waste retrieval demonstration in tank S-112 by 9/30/05. <u>Technology Demonstration – Tank C-104</u> • Submit functions and requirements for tank C-104 technology demonstration by 12/31/01. • Complete tank C-104 cold technology demonstration by 6/30/04. • Complete tank C-104 technology demonstration design by 9/30/04. • Complete tank C-104 technology demonstration construction by 9/30/06. <u>First Full-Scale Retrieval – Tank S-102</u> • Submit functions and requirements for tank S-102 retrieval by 10/30/02. • Complete tank S-102 retrieval system design by 3/31/04. • Complete tank S-102 retrieval system construction by 11/30/05. • Complete tank S-102 waste retrieval by 9/30/06. <u>Second Full-Scale Retrieval – Tank To Be Determined</u> • Establish completion date for initial waste retrieval by 12/31/02. • Submit functions and requirements document by 4/30/04. • Complete initial retrieval project design by 6/30/06.

	NOTE: Actual project schedules establish earlier due dates to ensure the meeting of the Tri-Party Agreement milestones listed above.
14	***Definition of Solution:***
15 *	***Targeted Focus Area:*** Tanks Focus Area (TFA)
16	***Potential Benefits:***
17 *	***Potential Cost Savings:***
18 *	***Potential Cost Savings Narrative:*** It is difficult to quantify the cost savings potential of alternative retrieval technologies without the performance data that will be derived through technology demonstrations conducted in response to this need statement. In general, alternatives to past practice sluicing are expected to be more costly, however, this cost increase will be offset by reduction in leakage loss potential during retrieval operations and subsequent requirements to characterize and remediate contaminated soils surrounding the SSTs. Anticipated cost savings or avoidances are on the order of tens of millions of dollars per tank.
**	***Technical Basis:*** Alternatives to past practice sluicing are needed to mobilize and retrieve wastes from potentially leaking SSTs to ensure adequate protection of the environment. This technology need statement will result in the demonstration of retrieval technologies that use little to no liquid to mobilize and retrieve SST wastes thereby minimizing the likelihood for leakage losses during SST waste retrieval. Demonstration of alternative retrieval technologies will provide cost and performance data to ensure the cost effective retrieval of wastes from Hanford's 149 SSTs in a manner protective of human health and the environment.
19	***Cultural/Stakeholder Basis:*** Leakage mitigation during SST waste retrieval operations is a major concern of the Hanford Site regulators and stakeholders. This concern is reflected in the Tri-Party Agreement milestones, comments on the Hanford Defense Waste Environmental Impact Statement and Record of Decision, Hanford stakeholder values, and in other public documentation.
20	***Environment, Safety, and Health Basis:*** Successful demonstration of retrieval technologies that use little or no liquid to mobilize and retrieve SST wastes will provide a more environmentally acceptable situation by minimizing the likelihood for leakage losses during retrieval operations. This will potentially reduce the amount of contaminated soils surround the tanks in the vadose zone requiring remediation and minimize the likelihood of contaminants being transported into the groundwater system beneath the tank farms.
21	***Regulatory Drivers:*** Recently negotiated Tri-Party Agreement M-45 Series milestones require alternative retrieval technology demonstrations focused on saltcake dissolution, fluidic mixing, and robotic crawler-based systems over the next 5 years. Demonstration of retrieval technologies that use little to no liquid will minimize the likelihood for leakage losses during retrieval providing a more environmentally and regulatory acceptable situation.
22 *	***Milestones:*** Refer to Section 13A on Schedule Requirements.
23 *	***Material Streams:*** Sludge, Saltcake, Liquid (RL-HLW-20)
24	***TSD System:*** Single Shell Tank systems
25	***Major Contaminants:*** Pu-238, -239, -240, -241; Am-241; U-238; C-14; Ni-59/63; Nb-94; Tc-99; I-129; Cm-242; Sr-90; Cs-137; Sn-126; Se-79; chromium; nitrate; nitrite; complexants (EDTA/HEDTA)
26	***Contaminated Media:*** Tank waste consisting of high molarity sodium hydroxide/sodium nitrate solution containing saturated saltcake and/or sludge.
27	***Volume/Size of Contaminated Media:***
28 *	***Earliest Date Required:*** 9/30/03
29 *	***Latest Date Required:*** 9/30/06
Baseline Technology Information	
30	***Baseline Technology/Process:*** The current baseline technology for waste retrieval from SSTs is past practice sluicing. This technique uses relatively large volumes of liquid introduced into the tank waste through a sluicing nozzle to mix and mobilize the wastes for retrieval. The resultant slurry is removed from the SST

	and is transferred to a DST using a slurry pump and waste transfer system. This baseline technology has been used at Hanford since the 1950's. The current baseline cost is roughly $35 million per tank to install a past practice sluicing system. While this technology has been used successfully in SSTs with structural and containment integrity, there is a concern over using past practice sluicing in tanks of questionable integrity due to the potential for leakage losses during retrieval operations. ***Technology Insertion Point(s):*** (M45 Series TPA milestones, as applicable)
31	***Life-Cycle Cost Using Baseline:***
32	***Uncertainty on Baseline Life-Cycle Cost:***
33	***Completion Date Using Baseline:***
Points of Contact (POC)	
34	***Contractor End User POCs:*** *David B. Smet, (509) 372-3537; F – (509) 372-2825; David_B_Smet@rl.gov*
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*Element of a Site Need Statement appearing in IPABS-IS
**Element of a Site Need required by CHG